TECHNOLOGICAL ADVANCEMENTS IN CPP BY USING AGRO RESIDUE IN BIO-METHANATION PROCESS FOR PRODUCING COMPRESSED METHANE GAS AS ALTERNATIVE FUEL OF LPG

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Abstract

In Century Pulp and paper Effluent generated from bagasse wash contains high COD in the range of 4000-5000 PPM.This cannot be treated in conventional effluent treatment plant. We have installed Bio-Methanation plant to treat bagasse wash effluent and create wealth to waste by generating Methane gas and used as a fuel. CPP installed state of art Bio methanation plant with the capacity 8.4 MLD and generating gas @10000cm3/day. Methane gas carries certain impurities like H_2S,CO_2 and etc which cannot be used directly in gas burner inplace of LPG. The Effective utilization of this gas we have installed 500cm3/hr gas scrubbing plant.In this Plant H_2S is removed by caustic scrubbing and CO_2 is removed by high Pressure water Scrubbing. After removing of impurities in the Methane gas the calorific value of CMG is approx 11100K cal/kg which is equals to 1.1 times of LPG. In CPP We are using LPG gas in Tissue plant for drying of Paper in Wetend and dryend burners effectively by replacing the LPG. On every day 4.0Mt of LPG is replaced by the CMG and running the plant Successfully since Jan'16. In Future we have a plan to replace the LPG gas with CMG in coating drying area. Presently the cost savings by using CMG is approx7.0 Crores/Annum.

Back Ground

Biogas typically refers to a mixture of different gases produced by the breakdown of organic in the absence of oxygen. Biogas can be produced from raw materials such as agricultural waste. Biogas is a renewable energy source and in many cases exerts a very small carbon footprint.

Biogas can be produced by anaerobic digestion with anaerobic organisms, which digest material inside a closed system, or fermentation of biodegradable materials.

Biogas is primarily methane (CH4) and carbon dioxide (CO_2) and may have small amounts of hydrogen sulphfide (H_2S), moisture and siloxanes. The gases methane, hydrogen, and carbon monoxide (CO) can be combusted or oxidized with oxygen. This energy release allows biogas to be used as a fuel; it can be used for any heating purposes.

LPG (Liquefied Petroleum Gas) is a key source of cooking fuel in urban India and its prices have been increasing along with the global fuel prices. Also the heavy subsidies provided by the successive governments in promoting LPG as a domestic cooking fuel has become a financial burden renewing the focus on biogas as a cooking fuel alternative in urban establishments.

1. Introduction

India is relatively low carbon economy by global comparison by two measures-CO_2 emission per ca-pita, and CO_2 emission per Unit of GDP in PPP (Purchasing Power Parity) terms. India's CO_2 emissions per ca-pita are well below the world's average. The industrial sector is one of the largest consumers of commercial energy in India, accounting for 43.8% of the country's total commercial energy use during 2013-14. Therefore, the fuel switch from fossil fuel to green energy (renewable sources of energy) is considered one of the untapped technological options which will help not only in reducing dependence on hydrocarbon resources but will also address to the threat of "Climate Change"

M/s Century Pulp &paper, Lalkuan India, generates 30,000 to 32,000 m^3 wastewater during various operations of pulp and paper manufacturing process in CPP high COD stream segregated from the Mil effluent and it is being treated in activated sludge process, to achieve desired BOD/COD. Therefore, the CPP installed anaerobic bio-reactors based upon Upflow Anaerobic Sludge Blanket (UASB) Process to treat the bagasse wash water (BWW) in place of conventional anaerobic lagoon. BWW is generated from the bagasse yard and bagasse wet depithing.This full scale plant was only commissioned after successfully testing the anaerobic process at the pilot plant level.

1. Effluent Characteristics

The bagasse received from the sugar mills having 2% - 3% residual sugar is stored in the open bagasse yard by wet bulk storage method (made into slurry by mixing with water for forming compact pile) to preserve the quality for a period of 3 to 9 months. This facilitates washing off the residual sugars in the bagasse. The effluent generated form bagasse washing, during the receipt and during reclaiming operation, has relatively high BOD/ COD, low volume and easily biodegradable organic wastes. Thus, it has been treated in the UASB reactor.

The plant was designed for the average flow, with adequate buffer to take care of the maximum levels indicated in Table 1 and was based on the consideration that the effluent is free from chlorinated compounds. Since the pH of the raw effluent is in the range of 4.0 - 5.5, neutralization was done by using Milk of Lime (MOL).

Table 1. Average characteristics of bagasse wash wastewater.

Parameters		Value		
	Unit	Minimum	Average	Maximum
Flow Rate	m^3/hr	300	350	400
pH	-		4.0 -5.5	
BOD_3	ppm	1100	1300	1400
COD	ppm	3000	4000	4500
Suspended Solids	ppm	2500	2750	3000

3. Design, Process Layout and Description of the Biomethanation Plant for Treatment of Bagasse Wash Effluent

The plant has been designed to handle 8400 m^3/day of bagasse wash water having average 4000 mg/l COD concentration which is organic loading rate of around 4.0 kg COD/m^3/day. The process flow diagram is depicted in Figure 1.

The bagasse wash water generated in the bagasse yard is received into the Pre settler and it is the designed &installed first time in India for bagasse paper plant. The Unique mechanism is travelling sludge sucker removal of sand and pith from settling zone. The sand/Pith removal efficiency varies from 85-88%. In Pre settler the Total Suspended solids reduced from 3000PPM to 500PPM.The separated SS are being taken to knotter for dryness improvement to burn into the boiler as replacement of fuel. After Pre settler the BWW is goes to the Buffer tank-1 for storage and further Processing. After Buffer tank-1 the BWW is going to the reaction tank there the chemical dosings are injected to boost up the PH and followed by the flocculation. The flocculation the material fed in to the Dissolved air flotation system. In CPP 2 sets of DAF is installed to remove the fine suspended material. Each DAF with the flow rate of 175m3/hr .The DAF is operating at 75-80% suspended removal efficiency.

The clarified wastewater from DAF is then taken to buffer tank where nutrients, such as, Urea and DAP are added. From buffer tank the wastewater is fed into UASB reactors through reactor feed pumps. The treated effluent from the reactors is taken into static mixer/tub settler to avoid overflow of anaerobic bacteria to aerobic system. Biogas generated in the reactor is passed through foam trap and sediment trap and stored in gas holder.

In UASB the inlet feed is bottom with Upflow velocity 0.2-0.3m/hr.The sludge blanket concentration Average is maintained 50000PPM to 90000PPM with the organic loading on sludge blanket 37.8Mt/day. The hydraulic retention time is given for 22 hrs.The gas production from the UASB reactor is 10000 Nm3/day.

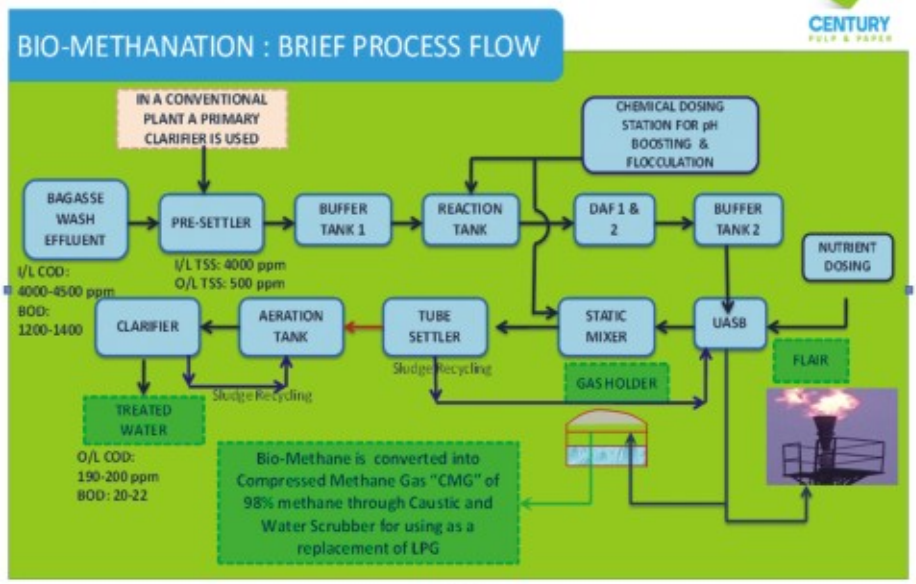
4. Performance of the Plant

Table 2. Average characteristics of bagasse wash wastewater received from DAF.

Parameters	Value			
	Unit	Minimum	Average	Maximum
Flow Rate	m^3/hr	300	350	400
pH	-		7.0 - 8.5	
BOD_3	ppm		800 - 1000	
COD	ppm		2200-2600	
Suspended Solids	ppm		500	

Table 3. Average characteristics of bagasse wash water After UASB reactor

Parameters	Value			
	Unit	Minimum	Average	Maximum
Flow Rate	m^3/hr	300	350	400
pH	-		6.5 - 7.0	
BOD_3	ppm		280 - 300	
COD	ppm		800-100	
Suspended Solids	ppm		<400	



Compressed Methane gas Plant

M/s Century Paper has installed a Bio Methanation plant that produces 500n.cu.m/hr biogas with around 70% methane content (v/v) & H_2S concentration of 5000 ppm.CPP to purify the biogas coming out of Biomethanation to the levels of CMG & utilizing the same for replacing LPG in drying process within the Tissue plant. With the current flow rates, CPP replacing around 6500 kgs of LPG per day.

The process will include two steps:

Step 1 : Removal of H_2S from biogas

Step 2 : Removal of CO_2 from biogas to achieve a quality of Compressed Methane Gas

1. PLANT DETAILS

The plant comprise

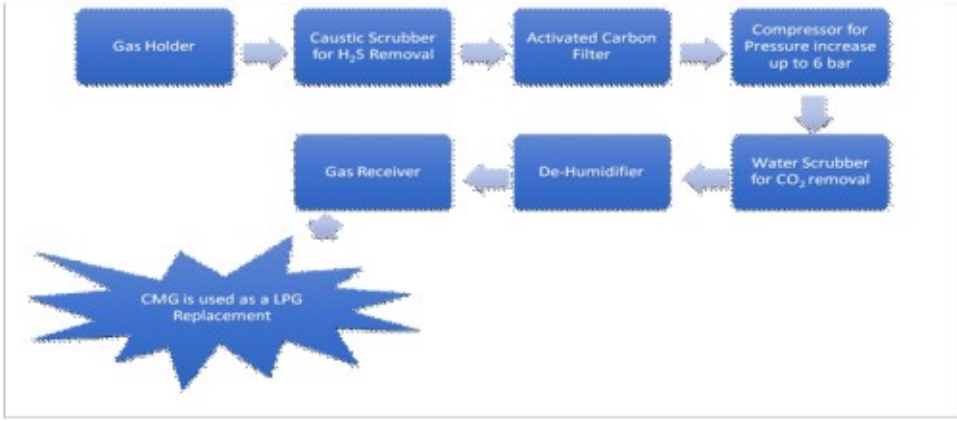
- ☐ H_2S REMOVAL PLANT (USING CHEMICAL SCRUBBING)
- ☐ methGENTM - CARBON DIOXIDE REMOVAL PLANT

Biogas comprises of various gases as mentioned below. The upgradation system is basically designed to isolate Ch_4 from this biogas through water scrubbing technology that is used for the removal of Co_2.

The typical composition of raw biogas and purified Bio-CMG:

	Raw Gas Composition percentage (v/v%)	Purified Bio-CMG (prior to high pressure compressor) Composition percentage (v/v%)
CH_4	70	>98
CO_2	26	<2
H_2O	3.3 (saturated)	< 0°C Dew Point
H_2S	<5000 ppm	<10ppm

Block diagram of Compressed Methan Gas process



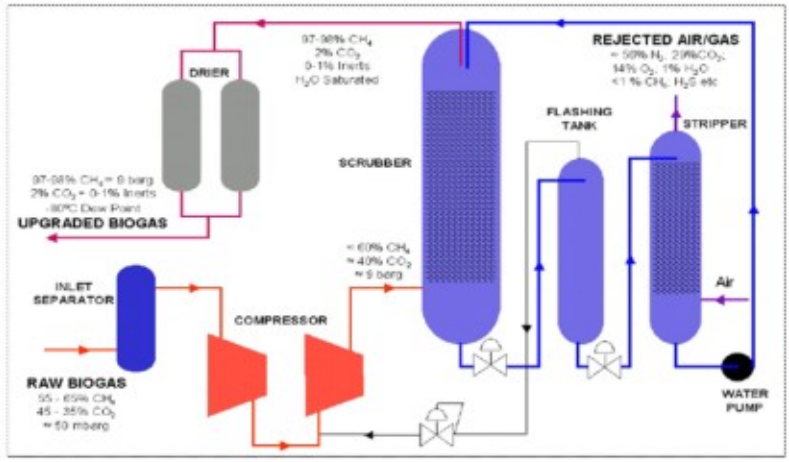
In the first stage the hydrogen sulfide in the gas is being removed by H2S scrubber tower.The Biogas is introduced into the packaged bed from the bottom of the scrubber tower,and the caustic lye solution(NaOH) with water (H2O) is introduced from the top of the tower through a pump.In the counter current flow the reaction takes place in the packaged bed.The gaseous product of the scrubber tower is collected at the top of the tower.The caustic circulation tank is used to collect the liquid products from the scrubber tower and is recirculated through a centrifugal pump.

The Biogas collected from the top of the scrubber tower is passed on to the polishing tower .In the Polishing tower the impregnated activated carbon bed is used as an adsorption medium.The hydrogen sulphide in the biogas gets adsorbed on the activated carbon surface.The hydrogen sulphide free gas is then passed on through the knockout drum for the removal of the water molecules present in the biogas.A compression of the biogas upto 500m3/hr is done using a compression stage.

methGENTM - CARBON DIOXIDE REMOVAL PLANT

In the second stage the carbon dioxide removal is done through the absorption tower.The absorption action between the pressurized water and the biogas takes place in a counter current mode in the absorption tower.The carbon dioxide gets absorbed to the water molecules in this action.The carbon dioxide absorbed to the water is collected at the water holding tank.The gaseous product from the absorbed tower is taken through the dehumidifier to maintain the humidity in the biogas.The biogas analyzer is used to measure the level of purification.The biogas at this stage is maintained at the specific presuure level to deliver to the process.

In the absorption stage along with carbon dioxide ,methane also gets absorbed in a small quantity.This absorbed methane is removed by the use of flash tank.By depressurizing technique the absorbed methane in the water is removed inthe flash tank.The removed methane is then tranferred to the knockout drum,where the recycling of the gas will take place at this stage of compression.The water in the flash tank containing traces of carbon dioxide is recycled in the degassing tower.The countr current reaction with pressurized air removes the absobed carbon dioxide in the water.The water at the end of the tower is collected in the water holding tank.The collected water is used again by pumping back into the absorption tower.



The CMG gas plant supplied CMG gas to the tissue plant through the line pressure of 2.0kg/cm^2.In tissue plant the pressure is reduced from 2.0kg/cm^2 to 0.2-0.3kg/cm^2 by Pressure reducer and then feed to the gas burners. In gas burners safety interlocks are provided for the Pressure and temperature controllers and line leakages. The Hot air temperature is maintained from 290^{0}C to 350 ^{0}C to dry the paper in paper machine wet and dry end.

HAZOP Safety Study and Measures in the Biogas generation and Utilization facilities:

In CPP HAZOP (Hazardous &Operability) Study has done in the Biogas and Utilization facilities through the Safety Consulting Services in 2015.

The objective of the Study was to identify the hazards by visualizing hypothetical deviations in the plant parameters with the help of set HAZOP guide words to ensure that adequate arrangements exists to warn the operators and take adequate Preventive or control measures.

-The Following Safety Measures has been taken by using seven guide words.

1) Process Control by PH monitoring and chemical analysis of the samples.
2) Ingress of air into the gas system and possibility of explosion of the reactor and duct to avoid this blower trips provided before the pressure approaches to zero.
3) Mist traps are provided at outlet of the gas reactor to avoid corrosion of MS line.
4) Local flare stack with sufficient height and due care has been taken to vent the gas from the vessel in case of any leakage of the FRP line.
5) Routing the gas from the places away from the fire Prone areas.
6) A dispersion modeling study has been done to estimate the likely concentrations of the gas or its toxic ingrediants and radiant heat loads at surrounding objects at different distances and heights.
7) Hydrant lines have been provided to cool the objects in case of fire.
8) Butterfly valves have been provided at the outlet of the reactor to stop the fire.
9) Additional gas flaring system has been provided at the reactor side to control the fire.
10) Usage of inhibitors to stop the reaction in case of emergency should be considered.
11) Ignition of leaking gas due to static sparks to control this graphite impregnation of the inner layer of FRP has been done to promote conductivity.

Saving Calculation working sheet by using CMG in Place of LPG in Paper Drying Process.

a) Average Tissue Production : 70TPD
b) Total Gas requirement Per Ton of Paper : 77kg/Mt
c) Present LPG replaced by CMG is 50% which is equal to 38.5kg/Mt
d) Presently CMG generation and Consumption per day is : 3080kg/day
e) Cost of LPG considered per Kg is 60 Rs/-
f) Savings by using CMG inplace of LPG Per day is = 3080*60=184800 Rs/-
g) Annual savings by using CMG inplace of LPG is =184800*360=6.6 crores.

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